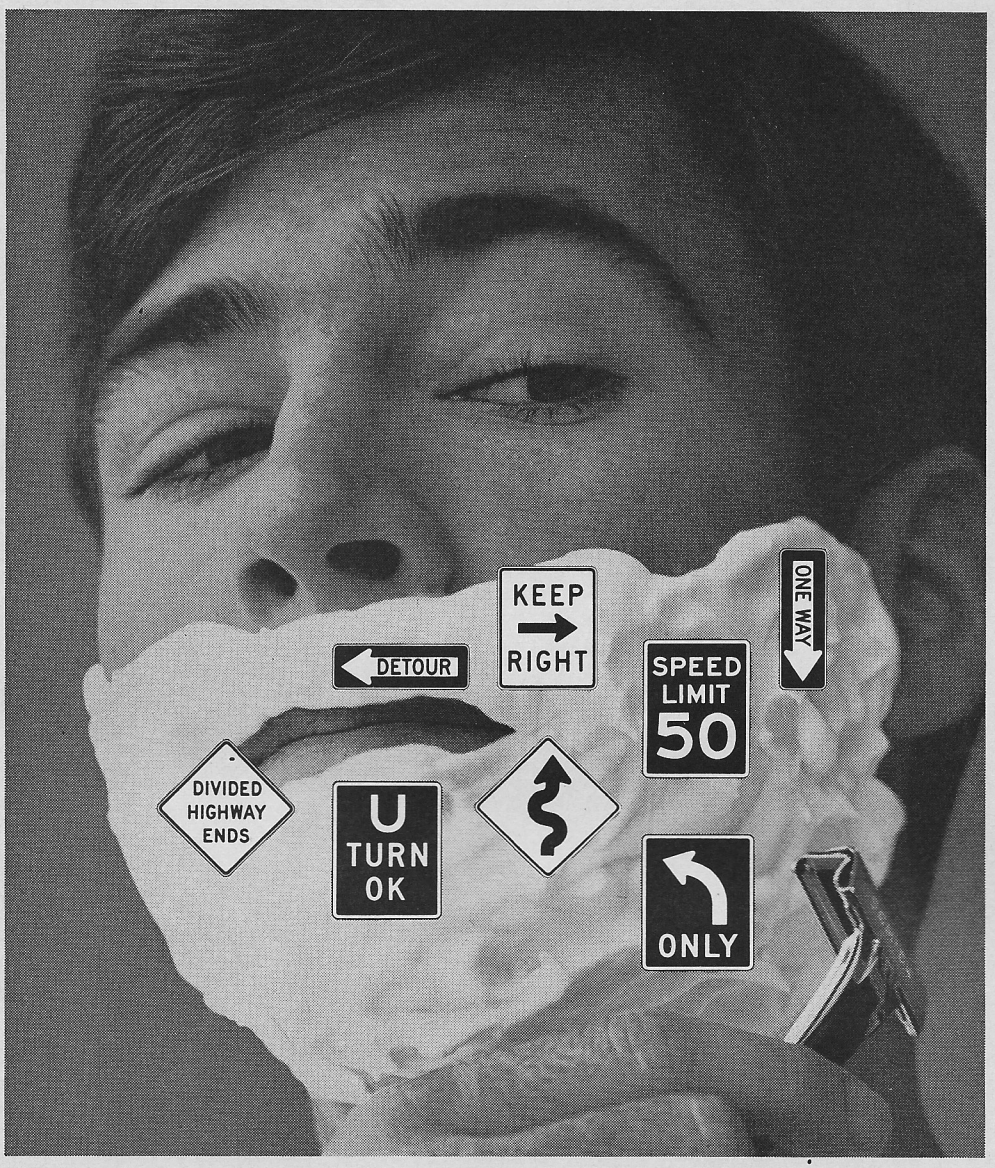
MAY 9, 1968 • VOL. 23 • NO. 13 • A SCHOLASTIC MAGAZINE

SENIOR SCIENCE

For Classes in Biology, Chemistry, Physics, Earth and Space Science

Drugs from the Sea

Arthur Fisher



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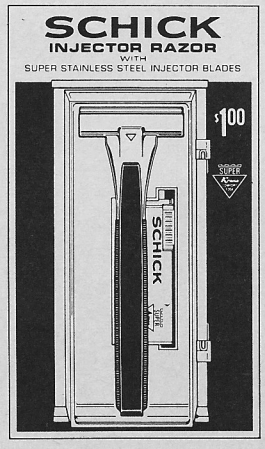

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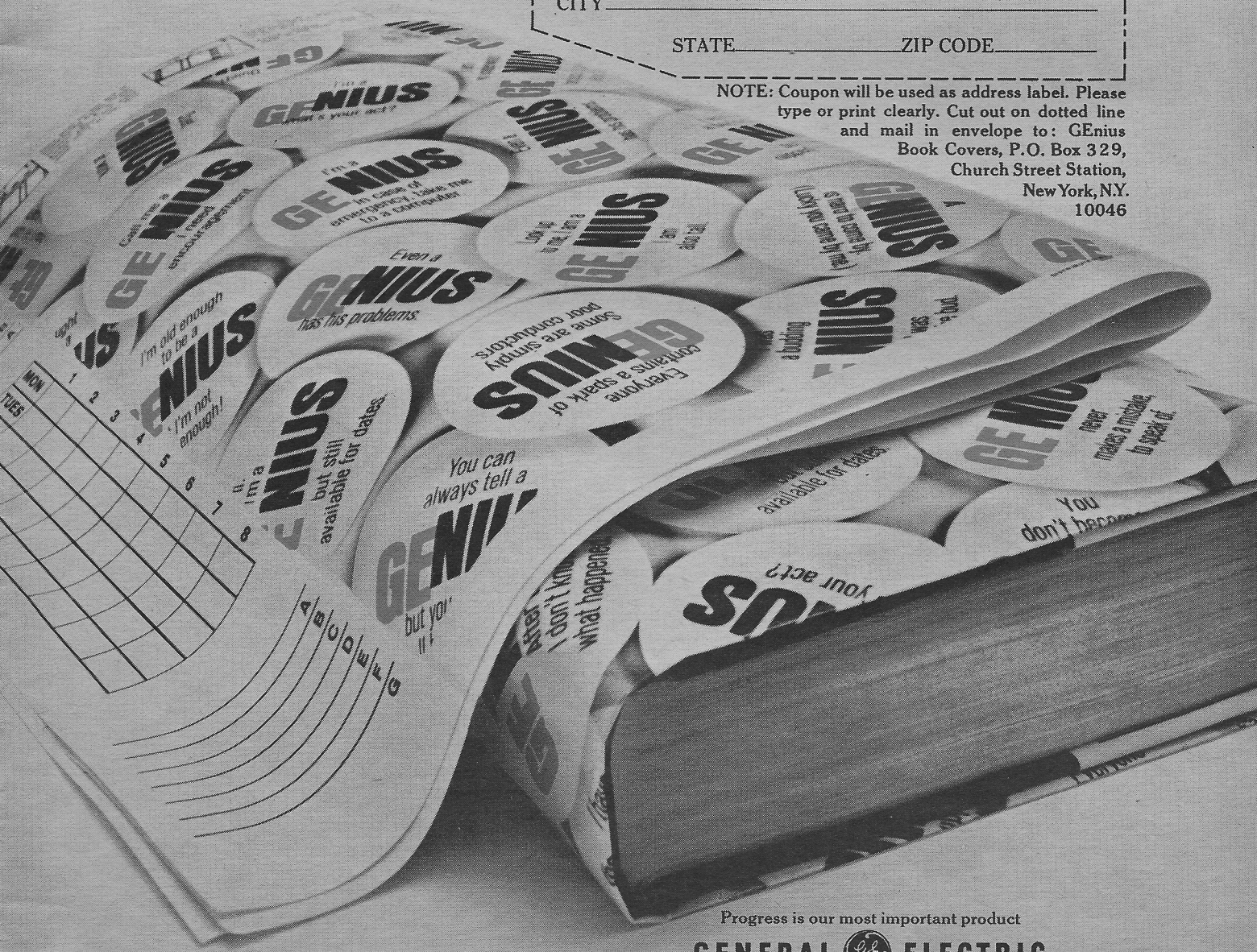
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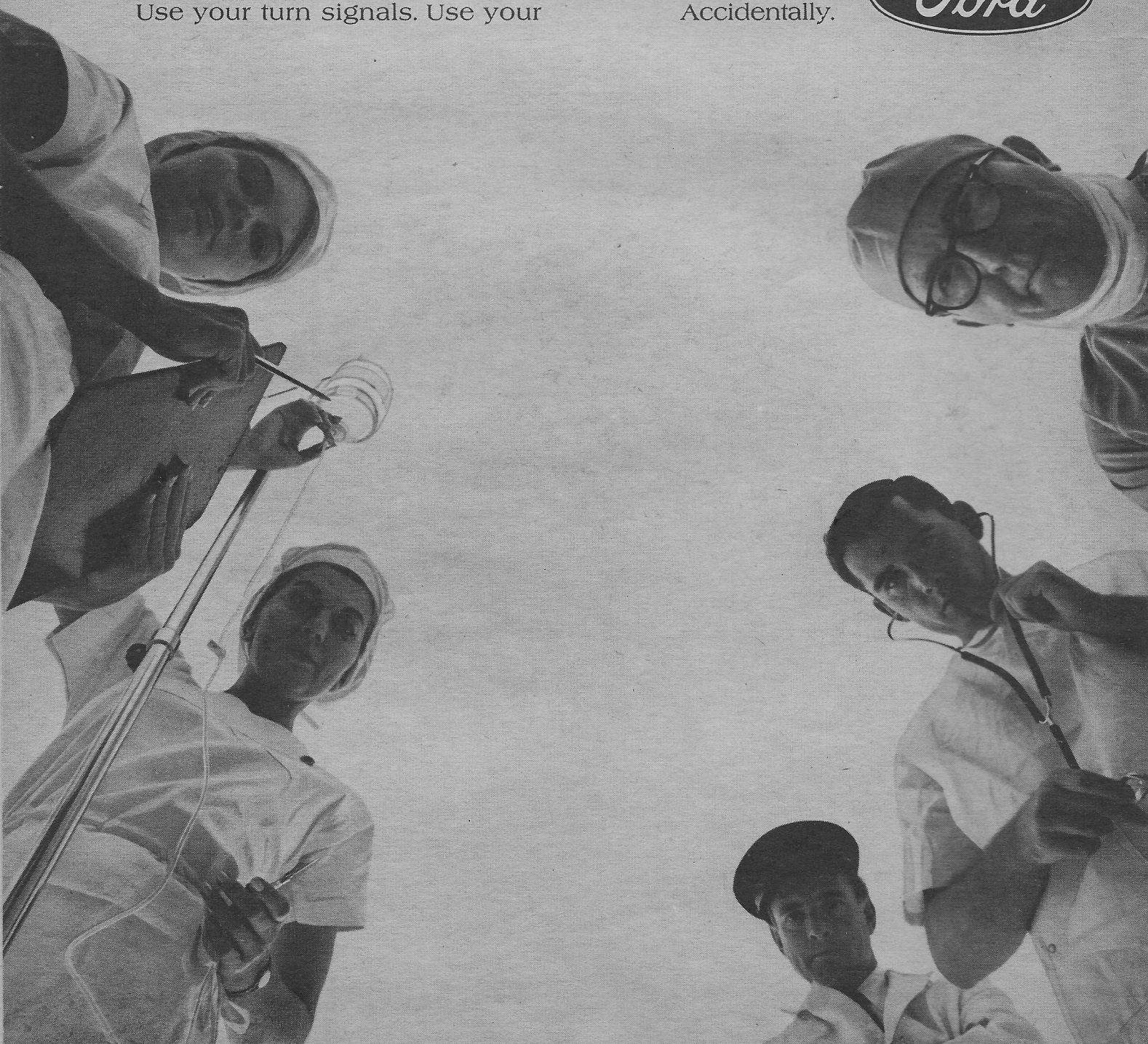
Accidentally.

Ford



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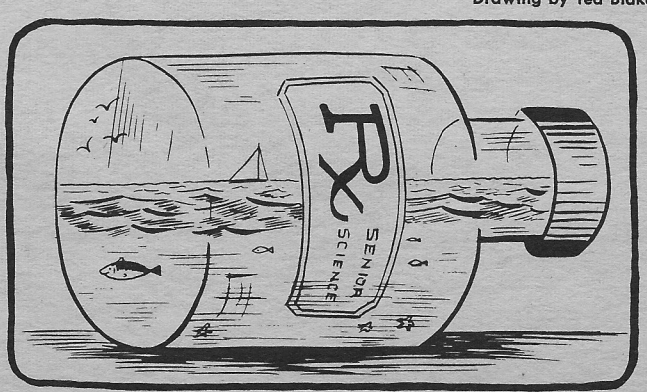
Cover photo: Arthur Fisher

Our Front Cover

From time beyond ken, healers have prescribed an amazing variety of cures for their patients' ills. Mud has been daubed on wounds, bark chewed to reduce fever, roasted ox livers consumed to restore night vision. Most of these primitive treatments seemed nonsensical to later, more sophisticated, physicians. But modern science has learned that some of the most ridiculous-seeming remedies do, in fact, work, because they contain ingredients wholly unsuspected until recently. After all, antibiotics are found in the soil, quinine in the bark of the cinchona tree, and vitamin A in liver. Still, what would your reaction be if someone claimed a cure for cancer might come from the sea? Check your reply by reading the article beginning on page 7.

Drawing by Ted Blake



EARTH'S FLIP

SEVEN HUNDRED THOUSAND YEARS AGO – give or take a few thousand years – an "Earth-shaking" change overtook our planet. Outwardly, nothing had happened. The sun still shone. The wind still blew. Primitive men of the time still hunted and fished in a warm and glacier-free world.

Yet, an important page in the history of the Earth was being written. For the Earth's magnetic field – one of the most striking features of our planet – had collapsed and entirely disappeared! If a compass had been placed anywhere in the world at that moment, its needle would have spun in aimless circles.

About 5,000 years later, that imaginary compass needle would have stopped spinning. The Earth once again had become magnetized. But this event was even stranger than the original disappearance of the field. The end of the compass needle that would have pointed one way 5,000 years before, now pointed in exactly the opposite direction.

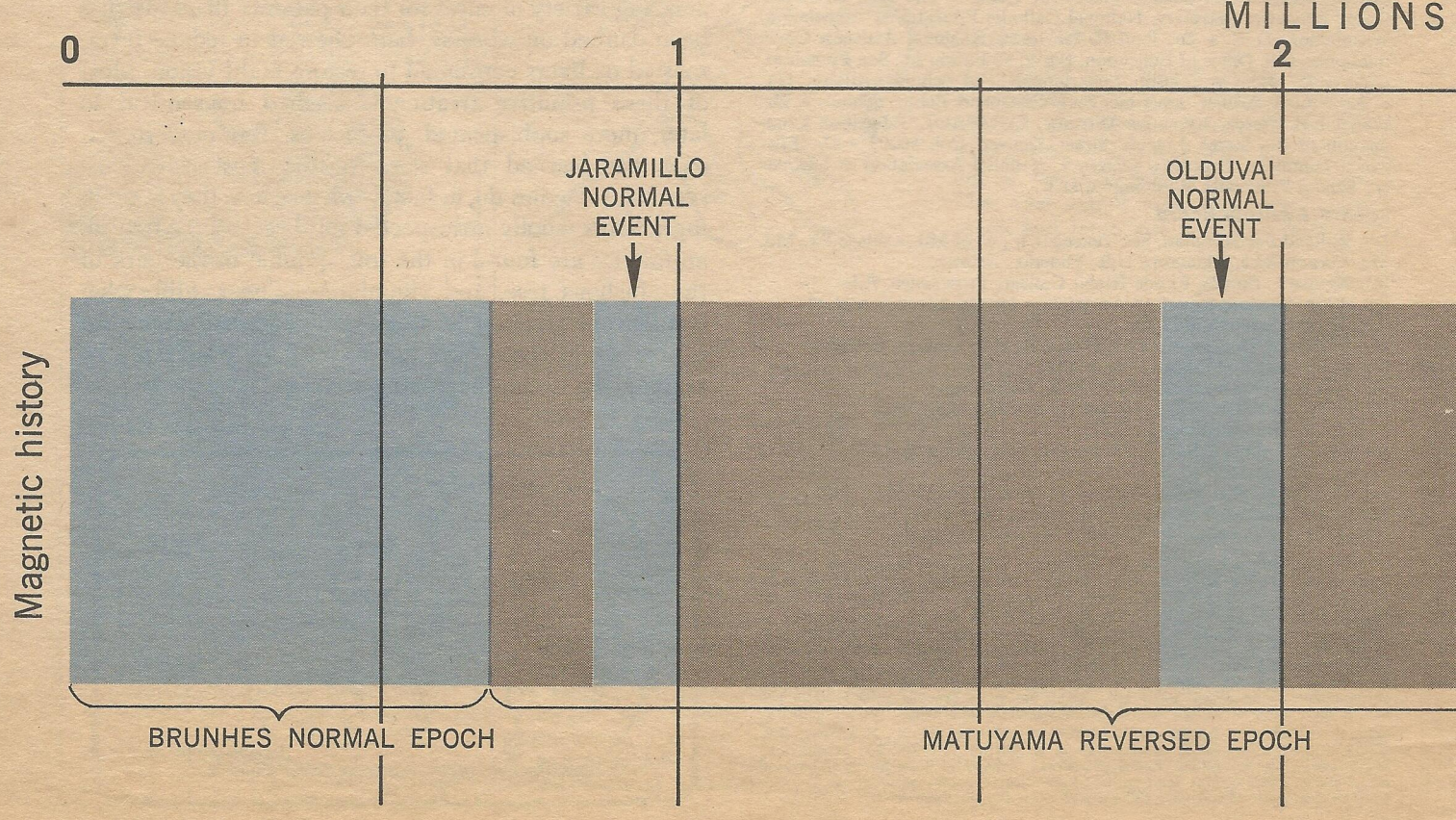
Somehow, the poles of the Earth's magnetic field had done a complete flip-flop. What was once the *north* magnetic pole of the Earth was now located in the *south*, and vice versa. The enormous "bar magnet" within the planet Earth had in some way reversed direction.

How do scientists know this reversal occurred? And how can they date it so precisely? The answers to these questions lie in the peculiar nature of volcanic rocks, and in the change that occurs in one of the elements found in the rocks.

Molten volcanic lava seeping from the Earth soon cools into immense sheets of rock. Within this cooling rock are tiny magnetic regions, called "domains," of iron and titanium oxides. As the molten lava cools, the domains align themselves exactly in the direction of the lines of force of the Earth's magnetic field.

At first, this magnetism is "soft" – it can change as the Earth's field changes. But as the rocks continue to solidify, a sudden change takes place. The magnetic alignment of the domains "freezes" – becomes permanent. No later shifts in the Earth's magnetic field can change it. So long as the volcanic rock does not remelt later on, every bit of it is thus packed with tiny "magnetic memories." For this reason they resemble the magetic tape used in computers and tape recorders.

This knowledge that the Earth's magnetic field is preserved in volcanic rocks is not a new discovery. In



FLOP-POLES

1906, the French physicist Bernard Brunhes was studying this magnetic record. He found some rocks that were magnetized exactly opposite to the direction of the present magnetic field. He cautiously dismissed the reversal as merely an odd local event, and his report was virtually forgotten. Twenty-three years later, a Japanese scientist named Motonori Matuyama made the same observation. He noted that all the *older* volcanic rocks he tested had *reversed* magnetism. But all the *younger* lavas had *normal* magnetism. He, too, decided that the reversal was just a local occurrence. The notion that a magnetic reversal might have occurred simultaneously all over the world received hardly any serious notice.

Using an "Atomic Clock"

Then, three young researchers from the U.S. Geological Survey became interested in the problem. Sitting around a campfire in the White Mountains of California in 1961, Earth scientists Allan Cox, G. Brent Dalrymple, and Richard R. Doell made plans to study the reversals of the Earth's poles.

They began by making certain that volcanic rocks really were a reliable guide to the *paleomagnetism,* or ancient magnetism, of the Earth. The most direct way, they decided, was to sample rocks from known volcanic eruptions. If the magnetism in the lava agreed with the direction of *magnetic north* at the time the rocks cooled, then they could be sure the magnetic record was an accurate one. (Magnetic north is not the same as *true* north. True north lies at one end of the Earth's axis of spin. Magnetic north occurs some hundreds of miles from the true pole. It wanders over an area of thousands of square miles and its exact location changes from year to year.)

Numbers of long core rock samples were drilled from lava flows that formed on Hawaii in the years 1907, 1935, and 1955. Then the samples were "washed" in a rapidly alternating magnetic field to remove any traces of "soft" magnetism that the samples might have picked up from such sources as lightning strokes. Only the "hard" magnetism of the original magnetic field was left. Finally, they measured the direction of the magnetism frozen in the long cores.

Their results? The magnetic direction of the samples was within a few degrees of the magnetic pole at the

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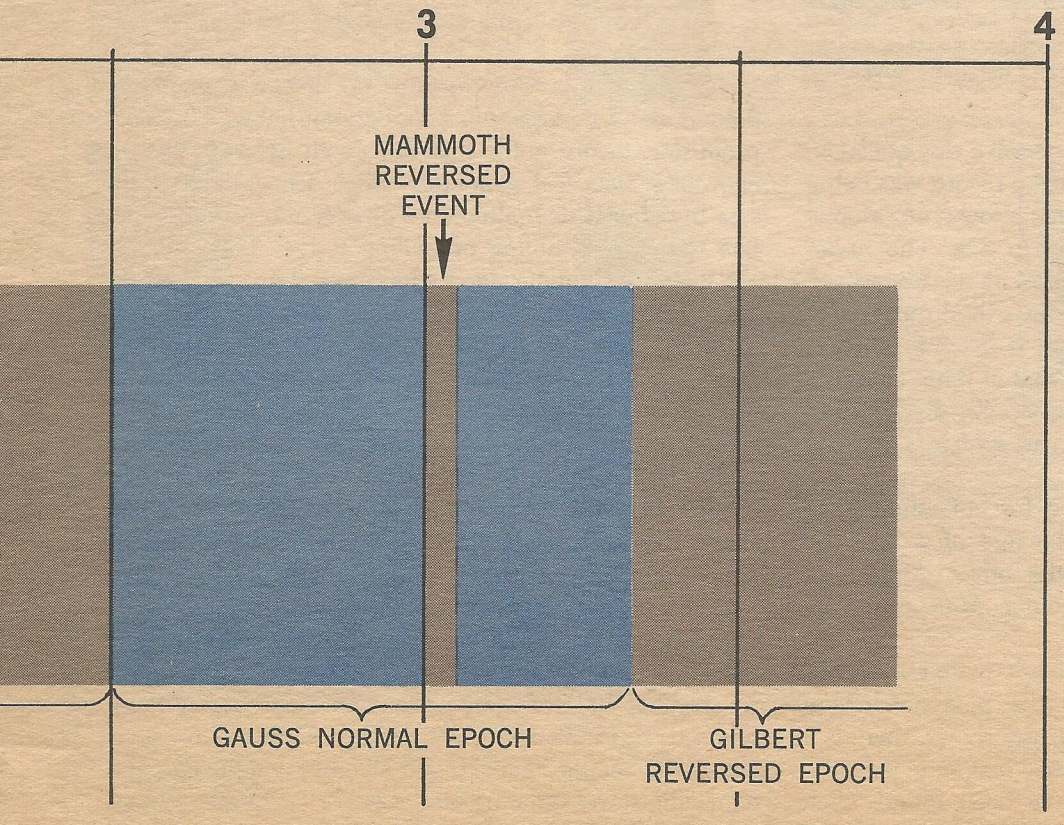


This diagram shows the four principal magnetic "epochs" broken by shorter magnetic "events." The periods when the Earth's magnetism was "normal" as it is today are colored. Times when the magnetic field's polarity was reversed are in gray. Time scale was worked out from paleomagnetic and radioactive dating data on more than 100 samples of volcanic rock from both hemispheres.

Senior Science Graphic

times of the eruptions. The rocks' magnetic memories were accurate.

The three scientists then examined "younger" rocks less than about one-half million years old. Invariably, their magnetism was normal. But in older lavas they got quite different results. In only about half of these rocks was the magnetic direction toward the present magnetic north. The rest were magnetically reversed. This pattern was duplicated by scores of investigators testing thousands of volcanic rocks from all over the world.

The scientists had shown that magnetic reversals were indeed world-wide events. But were they simultaneous? Or were they simply local, random "accidents," as the earlier scientists had thought?

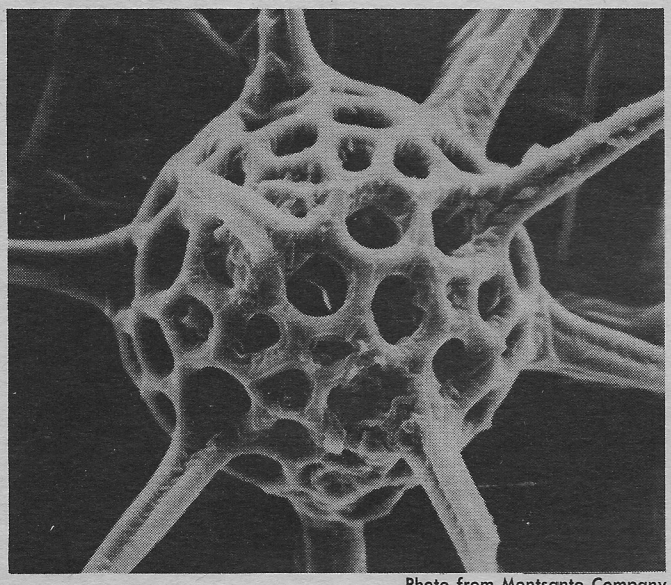


Photo from Montsanto Company

Lacy skeletons of some species of radiolarians ceased to appear in cores of deep sea sediments just after magnetic reversals.

Fortunately, there was a way to resolve this question. For at the same time that the magnetic record was being frozen forever into the cooling volcanic rocks, an "atomic clock" within them was beginning to tick. The *radioactive isotope* potassium-40 is present in almost all rock-forming minerals. Like certain other radioactive isotopes, such as those of uranium, it *decays*, or turns into other elements, in a known period of time. Uranium eventually becomes lead. Potassium-40 decays into argon-40, an *inert* or nonreactive gas, which is trapped in the rock.

Since we know the time needed for potassium-40 to become argon-40, we can tell the age of a rock by measuring the *ratio* of one to the other. Almost *no* argon-40, and the rock is very young. *More* argon-40, and the rock is older.

By now, more than 100 samples of magnetized volcanic rock have been dated by the potassium-argon method. As the diagram on these pages shows, there is a distinct pattern of normal and reverse magnetic polarity. Three major magnetic epochs have been found, each named for pioneering investigators of the Earth's magnetism. Within these periods are three short-term magnetic reversals.

Spurred by this discovery, marine geologists examined long plugs of sediment from the ocean's floor. They found that the microscopic particles of magnetic minerals settling to the bottom also aligned themselves with the Earth's magnetic field. Within one long tube of sediment it was possible to find nearly all the reversals discovered in many samples of volcanic rock!

Micropaleontologists – scientists specializing in microscopic fossils – studying these same cores, made another discovery. Just at the time when the magnetic field reversed, whole populations of tiny, single-celled animals called *radiolarians* became extinct. Was this a coincidence? Or was it a direct effect of the sudden loss of magnetism?

Questions Remain

Scientists know that the Earth's magnetic field acts as a barrier to high-energy radiation from the sun and from outer space. The collapse of the field would therefore admit increased doses of radiation. This radiation, in turn, might drastically increase the rate of mutation – genetic change – in tiny organisms, and possibly in larger creatures as well. And since most mutations are harmful, the change could well exterminate whole species. On the other hand, more successful mutants might launch new species.

All these discoveries have raised as many questions as they have answered. Why have the Earth's magnetic poles suddenly switched, not once, but several times? Have the reversals had a profound effect on life? No one really knows.

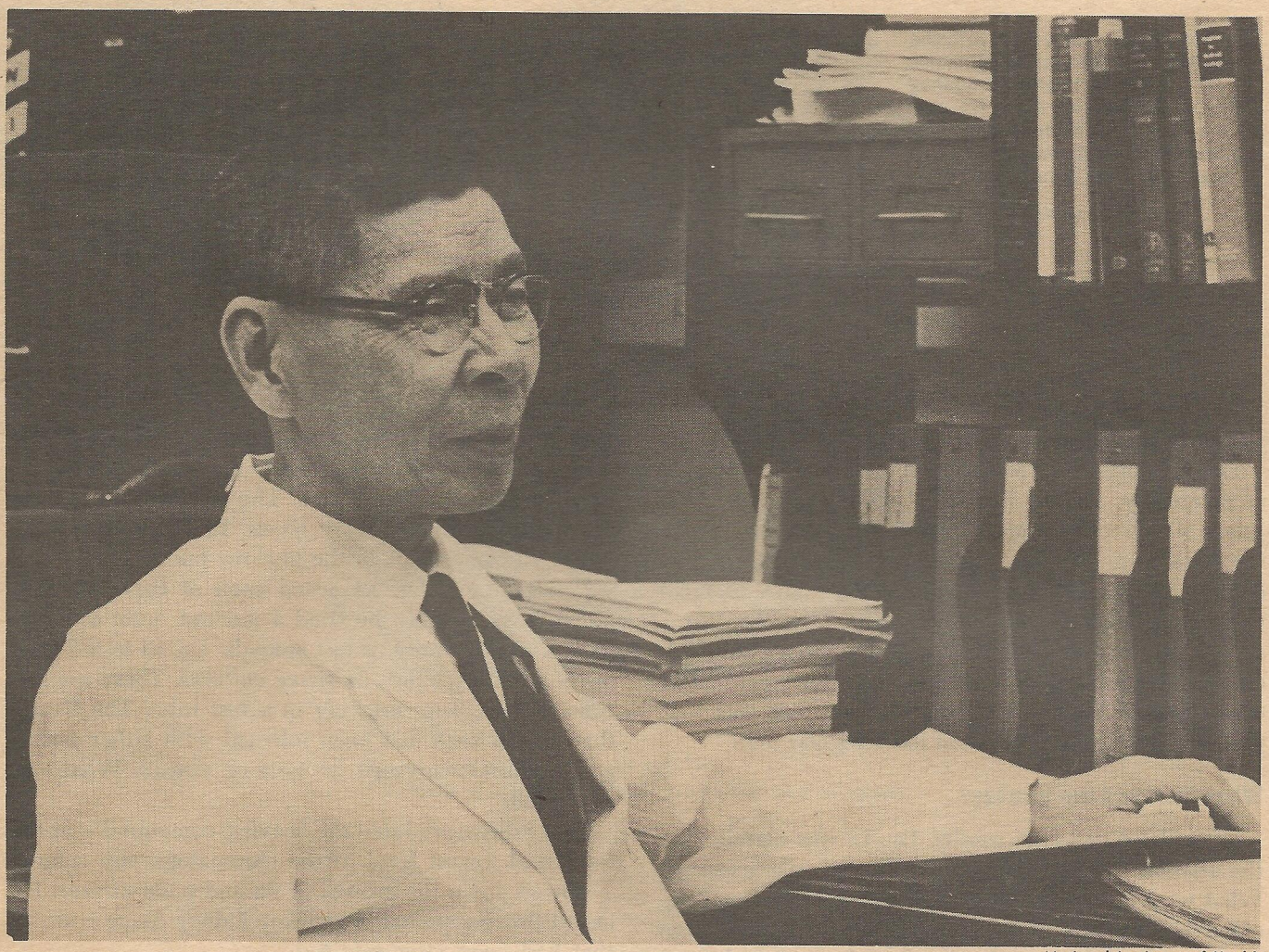
For that matter, why does the Earth have a magnetic field at all? Again, *geophysicists* do not know. The most promising theory holds that the Earth behaves like an enormous electrical generator. Heat deep in the Earth steadily churns its molten core of iron and nickel, much like the slow bubbling of boiling fudge. These metals act like the spinning conductors in a dynamo. The resulting electrical currents generate our magnetic field.

Support for this theory comes from an unexpected place – outer space. Space probes equipped with *magnetometers* – magnetic field detectors – have been directed toward the moon and Venus. Neither of these bodies is thought to have a molten core like the Earth's. Predictably, the information relayed back to Earth shows that their magnetic fields are either very weak or nonexistent.

One curious fact remains. As you can see from the diagram, our current "normal" magnetic epoch is almost the longest that has not been interrupted by a "mini-reversal" of 100,000 years or so. Could another of these reversals be in the offing? No scientist could say for sure. But if you should be looking at a compass some day and its needle starts spinning aimlessly. . . – THAYER WILLIS

Drugs from the Sea

Men have been mining the oceans for oil, minerals, and food. Medicines now join the sea's treasures.



National Institutes of Health

A pioneer in drug research, Dr. C. P. Li, thinks medicines of future may come from such marine animals as clams and abalones.

THIS IS A SCIENCE STORY that begins with Chinese food. Water lily soup? No. Chicken with walnuts? No. Spun apples? Wrong again. . . . But all these strange-sounding delicacies are from Peking. And in this ancient Chinese capital people have eaten a certain shellfish – abalone – for hundreds of years. Today, the white meat of the abalone is giving scientists clues to new drugs that may cure diseases ranging from a sore throat to cancer.

No one gave the abalone (a mollusk) much thought, apart from its food value, until a young Chinese doctor made a strange observation. As he patrolled the wards of a crowded Peking hospital, he noticed that the poorer patients somehow had more resistance to contagious diseases than others who had probably eaten a more nutritious variety of foods.

This struck Dr. C. P. Li, now a virologist at the National Institutes of Health in Bethesda, Md., as being very peculiar. Eventually, Dr. Li decided that the abalone – a cheap meat staple in the poor man's diet – might contain some germ-resistant substance. It took Dr. Li almost 40 years and a long route from China to the United States to test his idea. Twelve years ago, he began analyzing the abalone in the laboratory. Today, the scientists who work with him say that Dr. Li has just scratched the surface of what may be the biggest

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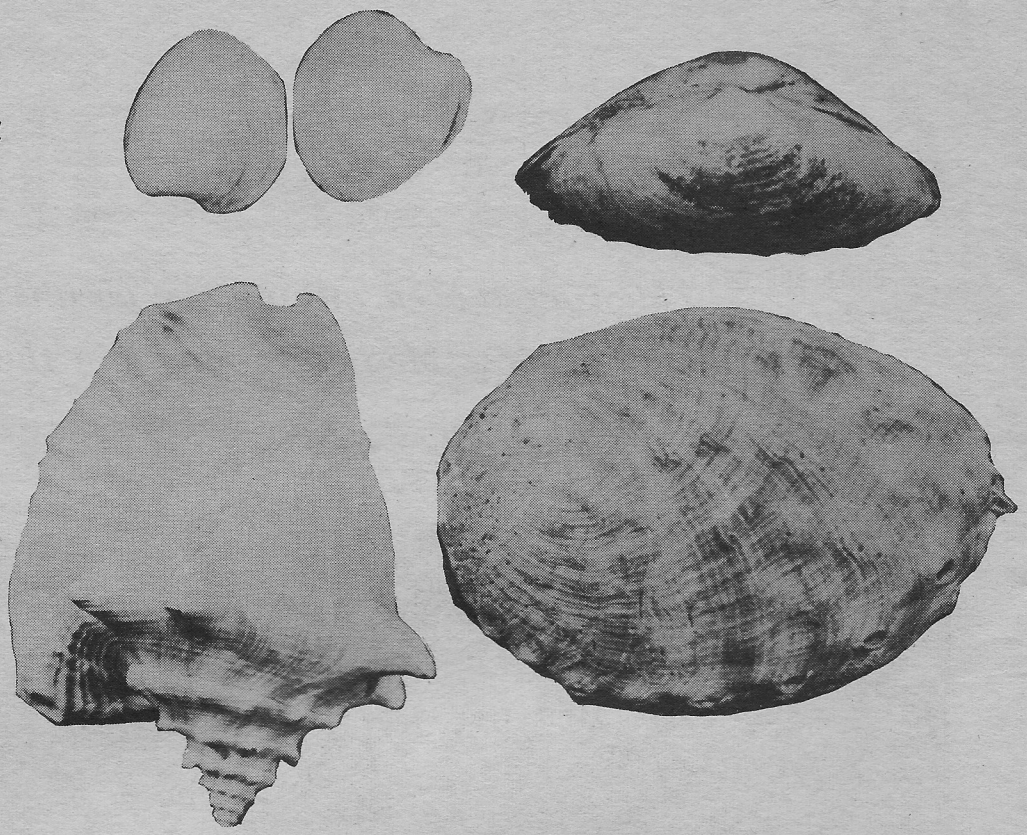


The queen conch, lower left, the abalone (lower right), the common clam (upper left), and the quahog clam (upper right) are being featured on the "menus" of some laboratories. Scientists think the marine animals may be sources of new medicines.

National Institutes of Health

source of potent drugs known to man – sea animals.

Dr. Li began his research by feeding white mice commercially canned abalone juice. He fed another group of mice of identical age and weight a diet without the abalone juice. This second group of mice was the *control* for Dr. Li's experiment. Both groups of mice were then infected with poliomyelitis virus. The virus (a microscopic organism that reproduces itself in living cells) attacks the nerve cells of the spinal cord. The death rate of the mice on the abalone diet was half that of the mice that had been fed a regular diet!

What Attacked the Viruses?

With these dramatic results, Dr. Li was certain that the abalone produced something that attacked viruses. What was this substance? Dr. Li and his colleagues decided to work with live abalones. They obtained a large number of adult animals that had been fished from Morro Bay, California. The scientists removed the large pearly shells from the abalones. Then they placed the abalones in a container, where the mollusks bled a bluish-white blood. The abalone blood was then *dialyzed* (a process whereby the small particles in a compound can be separated from the larger ones). The heavier compounds were then dissolved in another solution.

With this abalone juice solution, Dr. Li repeated the mouse poliomyelitis experiment, with the same results. This proved that the live abalones produced an *antiviral* compound (a chemical that destroys viruses).

Then Dr. Li tried to "split" the abalone juice into its different chemical compounds. For this job, Dr. Li used *chromatography* – a chemical method of separating substances. It is based on the rate at which different compounds pass through a column of a tightly-packed absorbent. The lighter compounds move quickly to the upper levels of the column. The heavier compounds are deposited in the lower levels. In this way, Dr. Li found 10 compounds in the abalone juice.

Painstakingly, Dr. Li tested each of these 10 components. To do this, he tried a method quite different from using live mice as test animals. Dr. Li tested each of the ten compounds on *tissue cultures*. These are live cells that are kept growing in a test tube. The tissues that Dr. Li used had been infected with either *pathogenic* (disease-causing) bacteria or viruses. What was the result?

Dr. Li discovered that the heaviest compound – at the tenth and lowest level of the chromatography column – slowed down the growth of flu and polio *viruses*. He tested this compound in monkey kidney tissue cultures that had been virus infected.

But the real surprise came when he tested the lightest compound – the first compound to rise to the top of the column. This compound stopped the growth of *bacteria* in the tissue culture. Bacteria are also microscopic organisms – larger than viruses – that cause disease. This meant that the abalone juice contained agents that could fight both bacterial and virus diseases! Dr. Li named these antimicrobial compounds *paolins*, after the Chinese word for abalone.

What are paolins? Dr. Li has not found the answer to that question yet. But he has some clues. The antiviral compound is, he thinks, a protein. Why? It has the very high molecular weight that characterizes proteins. But the compound also reacts positively to laboratory tests for carbohydrates. So, Dr. Li has concluded that the antiviral substance is a *glycoprotein*. This is a protein

that is combined with a sugar. Such compounds are found in human blood, in amphibian eggs, and in many microscopic organisms.

The only thing that Dr. Li knows about the antibacterial substance is that it is a compound with a very low molecular weight. He is now working to purify these compounds so that they can be identified.

Dr. Li has found paolins in other sea animals since he began his research on the juices of the abalone. The virologist reports that he went to market for fresh live oysters, clams, and lobsters; and fresh shrimps, flounders, and butterfish that had been kept on ice. He even tried some cooked Alaska crab in a laboratory analysis. Only the oysters and the clams paid off. From these two shellfish, Dr. Li extracted compounds that, like the abalone extracts, acted as both antiviral and antibacterial substances. The juices from the clams proved to be the most valuable. These compounds stopped the growth of cancerous tumors (rapidly growing disease tissues in the body) when they were fed to infected hamsters.

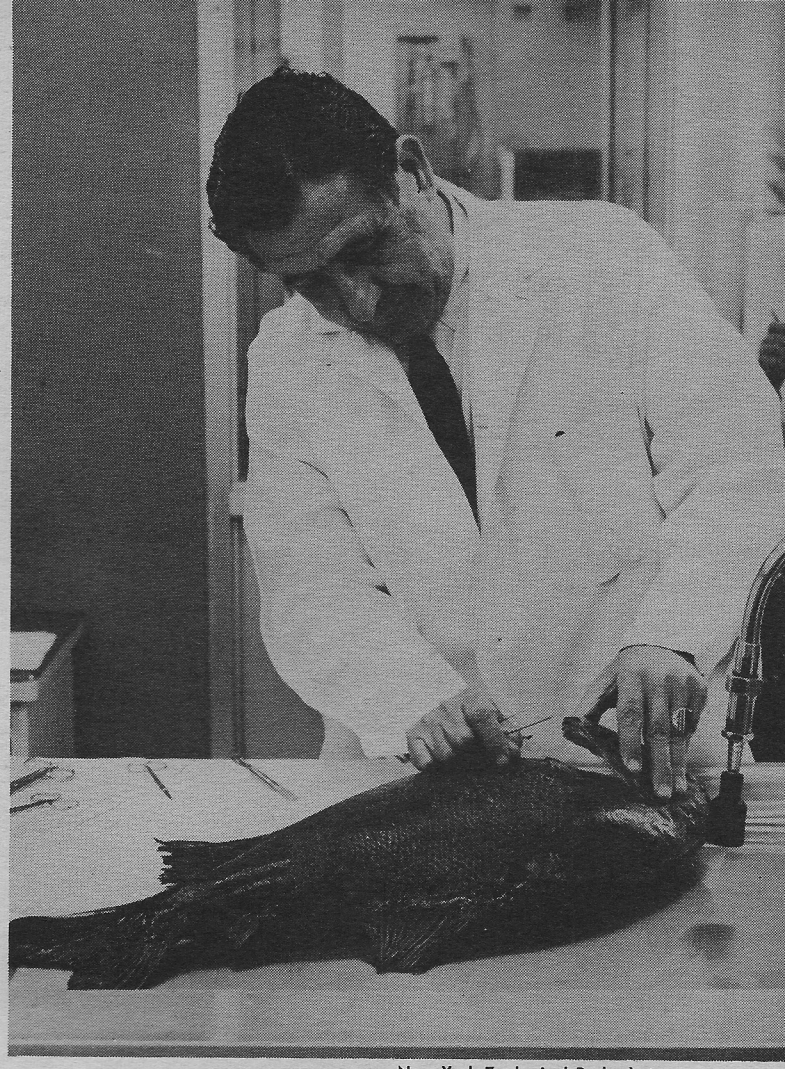
Effective against Human Cancer

Another researcher has also proved the clam's effectiveness against cancer tumors. Sister M. Rosarii Schmeer, a nun in the Dominican Order who is a biologist at the College of St. Mary of the Springs, in Columbus, Ohio, treated mice with cancerous tumors. She fed the mice a substance she had isolated in the body juices of the quahog clam. Although Dr. Li and Sister Rosarii are probably working with the same clam compound, she calls her compound *mercerene*. It stopped the growth of the tumors in the mice. Sister Rosarii went one step further. She applied mercerene to a tissue culture of human body cells infected with cancer. She reports that the human cancer cells were totally destroyed — with no harm done to the healthy cells in the tissue culture.

How did a scientist like Sister Rosarii get the idea of applying compounds from a clam to cancerous tumors? She says that she observed that cancer never appeared in invertebrate animals such as clams. She concluded that their bodies must be producing a substance that protected them from cancer viruses.

Sister Rosarii recognizes that her work has interested several physicians in feeding varying amounts of clams to human cancer patients. The physicians reported that, in a few cases, the growth of cancerous tissues was slowed down. However, these reports remain to be confirmed by laboratory work. Sister Rosarii says it will still be several years before drugs from clam extracts are available to physicians. Her efforts now are to develop equipment that will separate large enough quantities of mercerene so that scientists can determine its chemical composition.

Besides identifying the compounds they have extracted from the oyster, the clam, and the abalone, Dr.



New York Zoological Park photo

Dr. Ross Nigrelli of the Osborn Laboratories of Marine Science discovered "drug" compounds in the fluids of eel-like hagfishes. Here, he examines another fish in his lab.

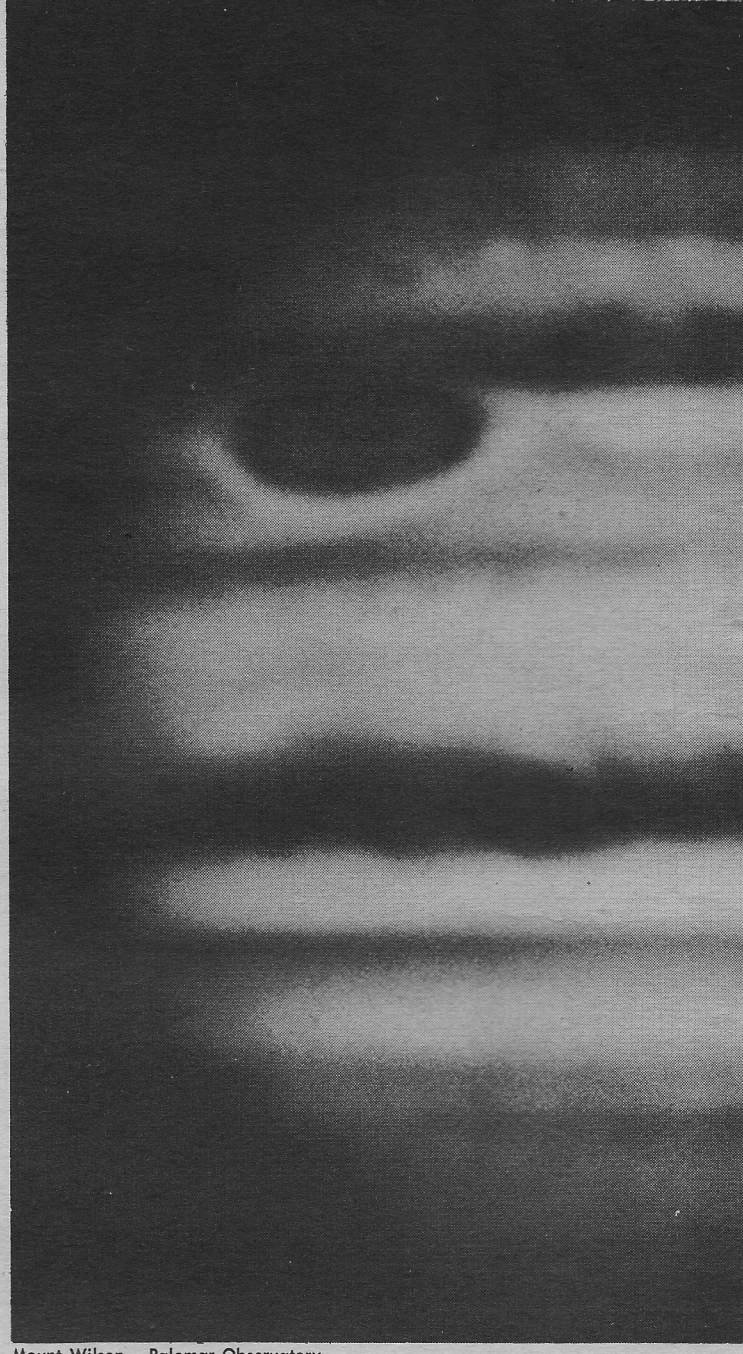
Li and Sister Rosarii still have another big question to settle. How do these substances work against viruses and bacteria? Many scientists have speculated on how the substances might create the effect that they do. Nobel Prize winner Dr. Albert Szent-Gyorgi has suggested that the sea animal compound may tip the hormone balance of the cell. This might either inhibit or enhance growth of the cell. His idea is that the cancerous viruses make the cell grow faster. Then, he says, the sea animal substances may work in the opposite direction. How? By stimulating those hormones that prevent the cell from reproducing. Another scientist has suggested that the paolins and mercerene may destroy either the DNA or the RNA of the disease viruses or bacteria. RNA and DNA are genetic materials that enable a cell to reproduce itself.

Whatever the answers to these questions may be, a colleague of Dr. Li's, E. C. Martino, sums up the progress sea animal researchers have made:

"Dr. Li accidentally discovered something many years ago in China. He had the perseverance to follow it up. Now we have a whole new structure of chemicals that may someday be used as valuable drugs. It's a field that should be of considerable importance — because one man kept onto an idea that had not been tried before."

— Ann Gill

LIFE ON JUPITER?



Mount Wilson – Palomar Observatory

JUPITER, giant planet of the solar system, is far from the heat of the sun (more than five times as far out as Earth). Yet it may be surprisingly warm – warm enough to support basic forms of life.

Using a special *bolometer* (an instrument to measure radiant energy) of his own invention, Dr. Frank Low of the University of Arizona's Lunar and Planetary Laboratory determined that Jupiter radiates two-and-a-half times more heat than it receives from the sun. What does this mean?

According to Dr. Gerald Kuiper, Director of the Laboratory, it means that, in some way, Jupiter must be generating heat. Almost all the radiant energy detected by Dr. Low must come from some source within the planet, and not from the sun.

What is the source of this heat? We don't know! But there are several theories to consider.

Substances near the center of such a massive planet (more massive than all other planets of the solar system put together – 318 times more than Earth) must be under enormous pressure. And such pressure could produce great heat by squeezing atoms together.

However, most astrophysicists feel that this explanation does not account for all the heat energy radiated by Jupiter. In their opinion, this radiant energy must be produced by nuclear reactions taking place within the planet. Yet, the most accurate calculations available indicate that Jupiter would have to be at least 30 times more massive than it is to produce the pressure – and thus the temperature – required to trigger nuclear reactions.

A Shrinking Planet?

But, heat isn't the only form of energy radiated by Jupiter. The planet has a very strong magnetic field. And enormous bursts of radio signals frequently come from the planet. Nuclear reactions are the most likely source of this radio noise.

What could trigger such reactions? If Jupiter were shrinking – geting smaller and more compact – individual atoms of its matter would collide more and more frequently as they were compressed. And these collisions would generate enough heat to produce nuclear reactions.

Many scientists believe that this process is under way. In fact, they consider Jupiter to be a developing planet, where clouds of gas and dust are slowly condensing into a solid mass. This would account for both the heat and radio emissions.

Could life take hold on such a developing planet?

Back in 1907, Swedish chemist and Nobel prize winner Svante August Arrhenius suggested this possibility. In his opinion, microorganisms in the forms of spores (tiny reproductive bodies) could survive the cold and vacuum of space. (This fact has since been demonstrated in various laboratories.) And, swept along by radiation pressure waves, these spores could travel from planet to planet, and even from star to star.

Most of the spores would be lost in space or destroyed by ultraviolet radiation. But some might settle on plan-

Varicolored bands of frozen methane and ammonia gases are believed to swirl around Jupiter. A great red spot, which no one can account for, can be seen in the upper left-hand quadrant of the giant planet.

ets capable of supporting life – and various forms of life would evolve, depending on conditions there. In this manner, Arrhenius argued, life spreads throughout the universe. He believed that original life reached Earth in this manner from some distant world. His notion is called the *panspermia hypothesis.*

Recently, in the light of modern astronomical knowledge, Dr. Carl Sagan of Harvard University re-examined the notion. Dr. Sagan doubts that living spores could travel to or from the four inner planets – Mercury, Venus, Earth, and Mars. Strong ultraviolet radiation from the sun would kill them. However, he concedes that conditions in the solar system may have been very different when life first appeared on Earth. Also, Dr. Sagan considers that it may be possible for spores to travel among the outer planets – Jupiter, Saturn, Uranus, Neptune, and Pluto – where radiation is less dangerous (because of the distance from the sun). However, he views the possibility of life arriving from other stars as an unlikely long shot.

If living microorganisms reached Jupiter, could they survive there? To attempt an answer to that question, we must consider the nature of Jupiter's atmosphere and surface.

Spectroscopic studies (measurements of light waves from the planet) indicate that Jupiter consists mostly of hydrogen (H) and helium (He), with lesser quantities of carbon (C), oxygen (O), nitrogen (N), and perhaps a few other elements. Clouds of *ammonia* and *methane* gases (the hydrogen compounds NH_3 and CH_4) swirl in the planet's dense and extensive atmosphere.

"Slushy" Zone

It may be difficult to tell where Jupiter's atmosphere ends and its surface begins. If we could travel with some future astronaut to the giant planet, we would encounter a very strange world.

Let's take such a voyage. About 470 miles out from the "surface," we enter a chilly (–120 degrees C) layer of very fine frozen ammonia crystals. Traveling inward, the atmosphere warms up and the frozen ammonia is gradually replaced by ammonia and methane vapors. (Some scientists suspect that water vapor also exists close to the planet's surface.) As we approach the surface, the vapor thickens – eventually changing to liquid, then to soft slush, and finally to a solid.

Could life exist in such an environment of noxious ammonia and methane? You and I couldn't. But scientists believe that the gases – methane, ammonia, hydrogen, helium, and water vapor – in Jupiter's atmosphere wreathed Earth when life first formed here. Laboratory experiments show that basic building blocks of life on Earth – *amino acids* and *nucleotides* – can develop in mixtures of such gases.

When Earth was a young developing planet, it probably had a very dense atmosphere similar to the present atmosphere of Jupiter. And the gases in that atmosphere probably provided the chemical basis for the beginnings of life on Earth. Then, as the gases escaped, the present oxygen-breathing life forms evolved. Can the same process be starting on Jupiter?

Until recently, scientists believed that the temperatures near the surface of Jupiter were far too low to support the chemical reactions necessary for life. However, Dr. Low's measurements of heat from Jupiter are making scientists think again. Several scientists now consider that some form of life may be developing on the giant planet. We can find out only by sending a well-equipped spacecraft to probe the environs of the planet. And we're many years away from doing that.

– Michael Cusack

SCIENCE IN THE NEWS

Spring Alligator Slaughter

Alligator-skin suitcases are priced as high as $1,000. And a pair of men's alligator shoes sells for around $70. To America's fast-dwindling alligator populations, these prices spell death.

Although the gators of the Florida Everglades – the last large gator sanctuary in North America – are protected by the U.S. Department of the Interior as an "endangered species," greedy poachers continue to slaughter the ancient reptiles. The slaughter usually increases at this time of year, the onset of the Florida dry season. The great reptiles swarm around the few remaining water holes, where they make easy killing for money-hungry poachers.

"By the end of May," a poacher recently confided to a reporter, "the alligators will be pretty well killed off north of Everglades National Park, and then the poachers will move into the park."

Unfortunately, Florida's State Game Commission cannot keep abreast of the illegal hunting. Only 22 wardens are available to patrol some 5,000 square miles of the Glades. Pitted against them are about 1,000 poachers. Everglades National Park rangers are also outmanned. Unless an all-out law-enforcement campaign is launched against the hunters – perhaps with the use of helicopters – the day is fast approaching when America's gators will all be goners.

"Killer" Ricciuti meets killer whale. Former Notre Dame boxer and Science World editor Ed Ricciuti spars with new arrival at New York Aquarium. Ed is now an Associate Curator at N.Y. Zoological Society.

N.Y. Daily News photo

The Robots Are Here

Have you ever wanted to own a robot? You may some day.

Scientists and engineers at the Stanford Research Institute, in California, have created one and are now teaching it to "fetch and carry." Though its engineering "parents" say that right now it's a pretty dumb machine, they're quite proud of its achievements. They've "taught" it to move around a room cluttered with objects, without bumping into things.

However, this simple achievement required long hours of tedious computer programing. The scientists believe that it will take months for the robot, or *automaton* as they prefer to call it, to "learn" to hunt down a particular object and bring it back. But, the robot is learning.

Signals from its single "eye" (a TV camera) are sent to its "brain" (a large computer) and processed so that it can recognize objects and places. It can even draw what it sees. Someday, it may work in environments dangerous to man.

Another robot is in the making at the Massachusetts Institute of Technology. While the west coast robot is being "trained" to be a messenger or porter, its east coast relative will be a builder. The M.I.T. robot is being designed and programmed to assemble complex structures.

Icy Theory

If a Lamont Geological Observatory scientist's theory is correct, the Earth may be in for another ice age about 80,000 years from now. Dr. W. S. Broeker, a *geochemist* at the oceanographic and geological laboratory, says that this forecast is in agreement with the pattern of past ice ages.

Dr. Broeker says that ice ages are caused by changes in the *tilt* of the Earth's axis of rotation, and by the cyclic *precession* of its axis. Precession is that movement of the axis that makes a spinning top, for example, seem to wobble.

When the tilt of the Earth relative to the sun *increases*, there are frigid winters and hot summers. When the tilt of the axis *decreases*, winters become warmer and summers cooler. This last situation favors the development of ice sheets. The cool summer temperatures do not melt all the snow and ice built up during the winter.

Dr. Broeker said that studies of ice ages show that the ice sheets formed very slowly, but melted in a comparatively short time. It takes tens of thousands of years for an ice sheet to reach its peak. This is followed by a rapid retreat that takes only a few thousand years. The last ice retreat from Europe and North America occurred about 12,000 years ago. Yet by 8,000 years ago, our climate was about the same as it is today.

Move to Spare the Horses

Communities in Montana and Wyoming are pondering the fate of some 200 wild horses roaming the barren Pryor Mountain area of south-central Montana and north-central Wyoming. The range is overgrazed, and the horses face eventual starvation. What can be done about it?

The Billings, Montana, office of the U.S. Bureau of Land Management offers three possible solutions: Trap and sell all the animals. Cut down the herd to about 15. Or select about 35 of the best animals, corral them, and then eventually release them when the range recovers.

Most local ranchers feel that one of these proposals should be adopted. But there's strong opposition. Several communities and individuals in the area – backed by some nature lovers throughout the nation – contend that such drastic measures are not necessary. They point out that thousands of acres of public land in the Bighorn Canyon National Recreation Area – currently used to graze private livestock – could be made available for the horses.

This is not the first time that the wild horses have created a furor. In 1966, the Bureau of Land Management tried

PROJECT POINTERS

Testing for TV X Rays

YOU have probably read or heard that X rays are emitted by some television sets. All that you need to conduct research on such X rays is some dental X-ray film (and a TV set).

You do not need to investigate the inside of the set, for the question is this: Do any X rays leave the cabinet? Thus, all of these experiments are conducted with the television cabinet completely closed. You can use a TV set in your home, in school, or at a friend's house. Your experiments will not interfere with the normal operation of the set.

There are two sources of X rays within a TV set. First, all TV picture tubes give off small amounts of scattered X rays from the face of the tube. Second, the high-voltage rectifier tube may also emit X rays.

X rays emitted by picture tubes: These X rays do not travel very far. They result from the electron bombardment of the tungsten phosphor on the face of the tube.

To check X-ray emission from the picture tube face, you will need a few unexposed dental X-ray films. Your dentist may be able to give or sell you this material. If you can't get dental X-ray film, make your own packets of film by wrapping pieces of any type of unexposed photographic film in light-proof paper. (Do this in a darkroom.)

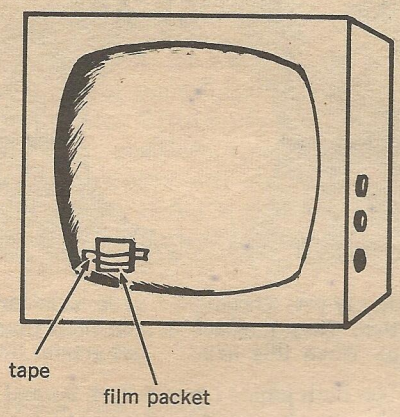
Attach a packet of X-ray or other film to the face of a TV picture tube with transparent tape (Fig. 1). Use a TV set that is operated for several hours a day. Leave the film in place for a week or more.

At the end of this time, remove the film and develop it in a darkroom. If you are using dental X-ray film, your dentist may be willing to process it for you.

Next, mount each piece of developed film in a 2-inch by 2-inch slide and project it through an ordinary slide projector (the type used to show color slides). You will probably see X-ray trails going off in all directions.

The larger the picture tube, the higher the voltage used to accelerate electrons to the TV screen. The electron beam "kicks" electrons in the tungsten phosphor up to a higher energy level (larger orbit). Then the electron drops back to its original energy level (smaller orbit). In so doing, the excess energy is emitted as visible light (which forms the picture you see), and also as invisible X rays.

Figure 1 Testing for picture tube X rays



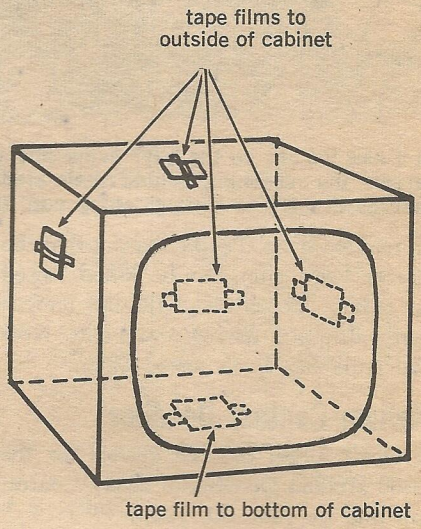


Figure 2 Testing for rectifier tube X rays

Color TV sets have higher operating voltages, and may emit more X rays. You may want to compare different sets, as well as different spots on the face of the same set. Some TV sets have lead glass in front of the picture tube to stop X rays from coming through the face; if the set you test does, your film will register nothing.

X rays from rectifying tubes: X rays from the picture tube were not involved in the recent newspaper publicity concerning X rays given off by certain defective color TV sets. The source of these X rays was the high-voltage rectifier tube, acting like an X-ray tube.

In a real X-ray tube, a glowing filament emits electrons, which are then accelerated by the high positive charge on a tungsten anode. In a high-voltage rectifier tube, a filament emits electrons, which are accelerated to the anode or plate. As some of the electrons strike the metal anode, some X rays are emitted, just as in an X-ray tube.

In a large TV set, the accelerating potential on the rectifying tubes may be as high as 30,000 volts — enough to produce strong X rays. To stop such X rays from leaking out of the set, the high-voltage rectifier tube is surrounded by a metal shield, which is supposed to eliminate the radiation hazard.

To test for X-ray leakage through the walls of a TV set, simply attach packets of unexposed film to the top, the sides, and the bottom of the set (Fig. 2). As before, the TV set should be in daily use for a week or longer. If you see no tracks on the developed film, you may conclude that X rays are not escaping from the set.

Geiger-counter tests: A Geiger-Müller counter, if you have one available, offers a quick and easy way to check a TV set for X-ray leakage. Perhaps you can borrow a counter from your science teacher.

First note the background count. Then pass the detector tube over all the surfaces of the set — sides, top, and bottom. If the count does not increase, no X rays are leaking out. You may want to compare the counts for X rays given off by sets with different-sized picture tubes. — ALEXANDER JOSEPH

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PROJECT: Testing Eye Dominance

FRANCINE BAY, WINNER, FORD-FUTURE SCIENTISTS OF AMERICA AWARDS
SCHOOL: PARKSIDE JR. H. S., MASSAPEQUA, N. Y. TEACHER: **WILLIAM STIMSON**

THIS PAST summer, a New York City newspaper featured a very unusual high school student in an article on its sports pages. A pitcher on his high school baseball team, this young athlete was driving opposing batters batty. Why? Because he could pitch with either hand – and frequently did so against the same batter on successive pitches!

Many ball players can bat either left- or right-handed, but very few have an advantage such as this ball player has. The preference for using one hand or arm (hand dominance) is partly hereditary, of course, and arises partly through habit. With practice, a person can become equally skilled at using either hand or arm – a condition known as *ambidexterity*.

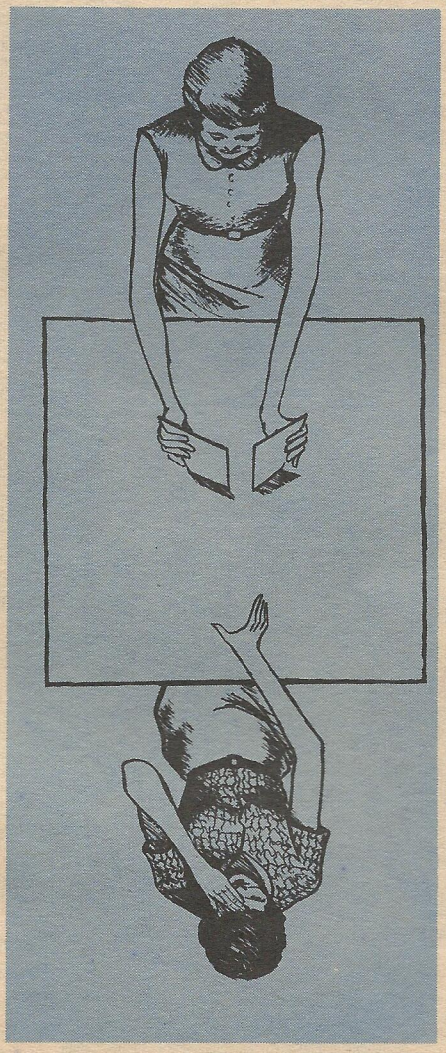
Hand dominance is due to a difference in dominance of the two halves of the brain. In left-handed persons, the right half of the brain is dominant; in right-handed persons, the left half of the brain dominates. Thus, dominance can be observed in other parts of the body, such as the feet, or the eyes.

Francine's Problem

In her project, Francine Bay conducted several tests to study differences in eye dominance between left-handed and right-handed persons.

Her Method

In the first part of her project, Francine used a setup similar to the one shown in the drawing to determine the eye dominance of a subject. She tested eight subjects, including one who actually was left-handed but had been taught to write with his right hand. She found that the three subjects who were left-handed looked through the slit with their left eyes. The four subjects who were right-handed looked through the slit with their right eyes. The person who was left-handed but wrote right-handed looked through the slit with his left eye. From these observations, Francine concluded that eye dominance usually is the same as hand dominance.



EYE DOMINANCE TEST

The subject held a large piece of cardboard in each hand with arms straight and well separated, then brought them toward each other until only a small slit remained between the cardboards. The subject was instructed to look (with both eyes open) at the open eye of the experimenter, who covered one of her own eyes with her hand. The subject, although thinking that she was using both eyes, was forced to use one or the other eye. The dominant eye was revealed to the experimenter as the only eye visible through the slit.

Part Two

Then, Francine had the subjects view three shapes (a circle, a triangle, and a square), each in four colors (red, white, yellow, and blue), from distances of three and five yards.

In these tests, the subject stood the specified distance from the viewed object and closed the left eye. The subject blinked back and forth from left eye to right eye, finally ending by closing the left eye, and quickly opening both eyes. Francine recorded the subject's observations and the test was repeated for all three shapes in four colors – a total of 12 times. Then the same procedure was repeated closing the right eye first. Thus, each subject viewed the test objects 48 times, 24 times at each test distance.

Results Observed

Francine based her conclusions about eye view movement solely on observations by the subjects during the tests. She concluded that the left eye view of a left-handed person has to move less to the right to achieve a "two-eye view" than does the right eye view (which moves left). On the other hand, the left eye view of a right-handed person has to move more to the left to achieve the two-eye view than the right eye view (which moves right).

Francine reported that color, shape, and distance of the viewed object seemed to affect the right and left eye view movement. In most cases, the greater the object distance, the more the eye views moved to achieve the two-eye view. Also, some of the subjects reported that the circles seemed to spin and the triangles seemed to move diagonally as they blinked back and forth from eye to eye.

Francine was aware of two sources of experimental error in her work. First, her conclusions were based on observations reported verbally by the subjects, and second, she had used no objective means of making her own observations (such as a specially designed apparatus, or a scale of some type).

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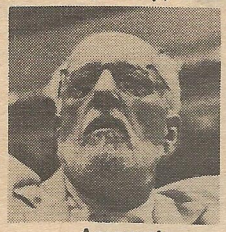
DISC-USSIONS

THE BEST OF THE NEW LPs

BY ROY HEMMING

with Robin McBride, Ed Coach, Buzz Royden

BUDGET ALBUM OF THE WEEK **Ravel: L'Enfant et les Sortilèges (The Child and the Sorcerers)—Ernest Ansermet, Suisse Romande Orchestra, Geneva Choir, Soloists** [*Richmond SR33086*]. Like Ravel's *Mother Goose,* this one-act operatic fairy tale is *not* a kiddies' work. It is much too sophisticated, witty, and satiric for most small-fry. But as a musical fantasy for more grown-up tastes, it remains one of Ravel's (and this century's) most irresistible creations. It has sections of shimmering impressionistic beauty (like *Daphnis and Chloe*), a wry fox-trot sung to fractured English lyrics, and a wildly comic duet between a baritone and soprano impersonating meowing cats. The framework for all this is the nightmare of a nasty little brat who dreams that the furniture in his house comes alive and joins the household animals to get revenge for the kid's antics. Ansermet's performance brings out both the glow and bite of the music superbly. Originally released in 1954 in mono only, this transfer to London's budget label marks the first appearance of the performance in stereo—and what a great difference I found comparing this re-release with an original mono copy. I don't know what London's engineers have done, but how *vastly* superior the new stereo edition is! Musically and sonically, this is a beauty of a budget LP. (R.H.)



Ansermet: glow and bite

CLASSICAL ALBUM OF THE WEEK **Handel: Julius Caesar—New York City Opera Production** [*RCA Victor LSC6182*]. The exploits of Caesar and Cleopatra have provided plots from Shakespeare to Shaw to 20th-Century Fox. Way back in 1724 Handel also made an opera of the story. Revived in 1966 by the New York City Opera in the original Italian, the opera has become one of that company's triumphs. Its stunning performance has now been captured on these three discs. Caesar is sung magnificently by bass-baritone Norman Treigle. Also good: Beverly Sills as Cleopatra, Maureen Forrester as Pompey's widow, and Beverly Wolff as Sextus. In Handel's time, opera was static by our standards, with little movement on stage. In the hands of conductor Julius Rudel, who staged the revival, the present performance seems alive with action—even on discs. (R.H.)

Schubert Lieder—Christa Ludwig [*Angel S3642*]. In an age of great singers who move impressively between soprano and mezzo-soprano roles (Price, Baker, Horne, Schwarzkopf, Lear, Resnik, etc.), Vienna-born Christa Ludwig ranks high. Moreover, she brings animation as well as her expected artistry and style to German *lieder*—as this set of 12 Schubert songs so beautifully shows. The most famous is his "Ave Maria" (to Sir Walter Scott's text), but all the others also show why Schubert's songs have long been considered among history's greatest. (R.H.)

ALBUM OF SPECIAL INTEREST **History of Rhythm & Blues, Vols. 1, 2, 3, 4** [*Atlantic SD8161-4*]. It would be impossible for any one record label to issue a truly definitive history of the R&B scene—but if anyone can come close, Atlantic Records can (and has!). Here is a superlative collection from the jazz-blues of the '40's to the thunder-based R&B beat of the '60's. Space permits mention of only a few of the more than 25 singers and groups in this series. A sample: *Vol. 1*—The Delta Rhythm Boys, Joe Turner, Ruth Brown; *Vol. 2*—The Clovers, The Five Keys, Ray Charles; *Vol. 3*—LaVern Baker, Clyde McPhatter, Chuck Willis; *Vol. 4*—The Drifters, The Coasters, Ben E. King, and Carla Thomas. It's a fantastic roster, and fortunately each performer is represented with recordings that are characteristic of his style. The extensive and informative notes by Jonny Meadows turns each volume into a true collector's album. (R.M.)

Scorekeeper

(see page 21)

I. Earth's Flip-flop Poles

1.T; 2.F; 3.F; 4.T; 5.F; 6.F; *7.T; *8.F; *9.T.

II. Drugs from the Sea

1.F; 2.T; 3.F; 4.T; 5.T; 6.T; 7.F; *8.T.

III. Life on Jupiter?

1.T; 2.F; 3.T; 4.T; 5.F; 6.T; *7.T; *8.T; *9.F.

ANSWERS TO PUZZLE

(see page 20)

	H	O	P	S			L	U	S	H
R		B	O	T	A	N	I	S	T		R
O	B		D	E	G	R	E	E		G	I
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SENIOR SCIENCE 5·9·68

Science on TV

Man, Beast and the Land

(Thurs., May 16, 7:30 P.M. EDT, NBC-TV)

Dramatic films of animals in the Serengeti-Mara region of East Africa will highlight this hour-long NBC News special. More than a million animals are said to live in this 20,000-square-mile region that straddles the borders of Kenya and Tanzania. Until recently, the area was protected by its location and by powerful warrior tribes, but now its native state survives through the concern and management of the governments and the people of the two countries.

The TV special was written, produced, and directed by NBC's Craig Fisher, who reports that he was most impressed by the numbers of animals roaming freely about, and their apparent lack of fear of man. "It was nothing to look up and see 30 giraffes moving across the horizon completely oblivious to me or the crew," he said.

Dr. and Mrs. Lee Talbot of the Smithsonian Institution, first wildlife ecologists to study the area, will discuss their work and findings. Solomon A. O. ole Saibull, chief conservator of the Serengeti-Mara, will also appear on the program.

Robert Scott and the Race for the South Pole

(Fri., May 17, 7:30 P.M. EDT, ABC-TV)

A re-creation of the ill-fated journey of Captain Robert Falcon Scott, originally shown last season, will be rebroadcast on this hour-long ABC special. The program, narrated by Douglas Fairbanks, Jr., and producer John H. Secondari, traces the steps taken by Scott and his party on their 800-mile trek from 1910 to 1912 to be the first to reach the South Pole. The men reached the Pole, only to discover a Norwegian team had beaten him to it by 33 days. None of the Scott party made it back to the base camp alive, though an account of the journey was found in Scott's diaries.

Director John Hughes and cameraman Bill Hartigan spent nine weeks in Antarctica, re-creating the expedition.

— PEGGY HUDSON

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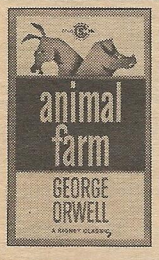
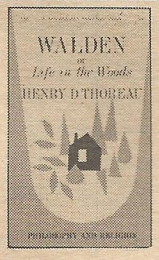


1. ANIMAL FARM, Orwell. Animals act like men — and pigs are boss! This biting satire by the author of **1984** attacks dictatorships with devastating force.



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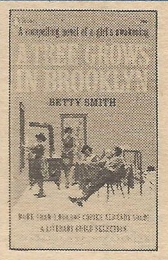

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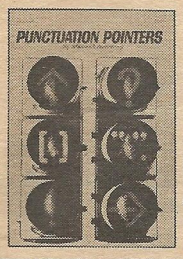

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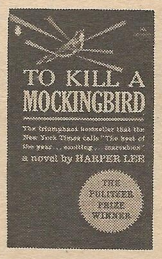

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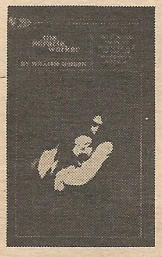
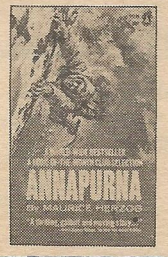
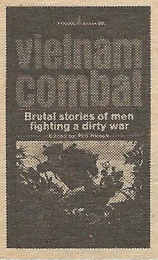


8. THE MIRACLE WORKER, Gibson. Adaptation of the prizewinning Broadway play—hit movie! Annie Sullivan and her struggles with the deaf, dumb and blind child, Helen Keller.



9. ANNAPURNA, Herzog. The magnificent epic of the men who defied danger and death to conquer the Himalayan mountain, Annapurna. Amazing chronicle of human courage.



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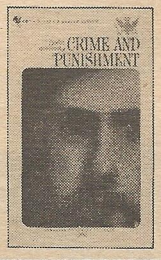

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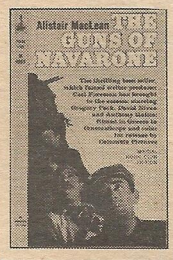

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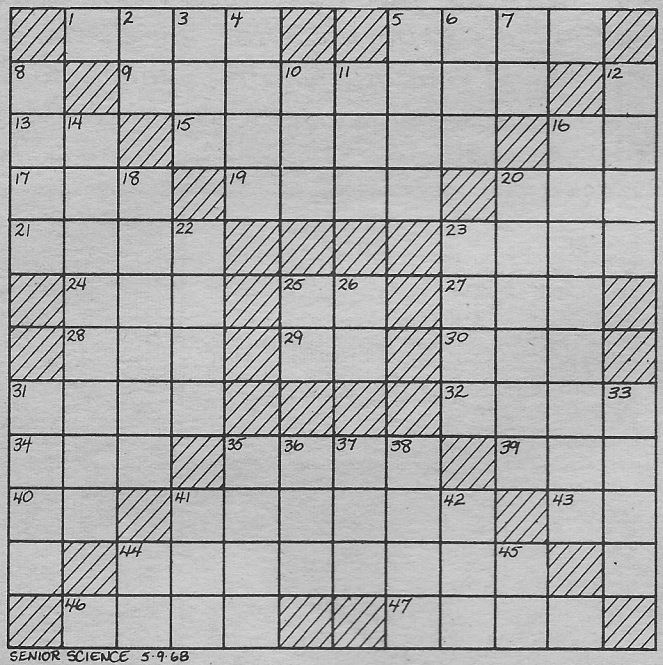
Students are invited to submit original crossword puzzles for publication in *Senior Science*. Each puzzle should be built around one topic in science, such as astronomy, astronautics, botany, geology, electronics, famous scientists, etc. Maximum of 50 words, of which at least 15 must be related to the theme. For each puzzle published we will pay $10. No entry will be considered unless it includes all of the following: symmetrical puzzle design and design with answers filled in, definitions, answers on separate sheets, and a statement by the student that the puzzle is original and his own work. **Puzzles must be symmetrical.** Keep a copy, as puzzles cannot be returned. Give name, home address, school, and grade. Address: Puzzle Editor, *Senior Science*, 50 West 44th Street, New York, N. Y. 10036. Answers to this puzzle are on page 18



ACROSS

* 1. Dried catkins used in brewing.
* 5. Characterized by luxuriant growth.
* 9. One who studies flora.
13. Russian river.
15. Extent.
16. U.S. enlisted man.
17. A limb.
*19. Fungus.
*20. Operculum, in mosses.
*21. Any tall bamboo-like grass.
*23. Climbing plant.
24. Being, in most abstract sense.
25. Exclamation.
27. Relative of the deer.
28. An insecticide.
29. Ate *(colloq.)*.
30. To equip.
31. _____ niu: a hybrid between Chinese domestic cattle and the yak.
32. A rare gas.
34. Enlarge *(abbr.)*.
35. Bar of wood or metal.
39. Ocean.
40. For example.
*41. Bryophytic plants.
43. Not Jr.
*44. Umbrella-shaped fungi.
*46. The joint of a stem.
47. National Defense Education Act *(abbr.)*.

DOWN

2. Same as No. 13 Across.
* 3. Case containing seeds.
* 4. Trunk of a plant.
5. Told an untruth.
6. Employ.
7. Abbr. for title of a holy person.
8. Loud noise.
10. In the past.
11. Naval Research Lab *(abbr.)*.
12. To be carried on the back of an animal.
14. Propagating.
*16. Ornamental trees native to eastern China.
*18. "Father of Genetics," did pioneering research on hybridity in plants.
*20. A group of bublous herbs with showy flowers.
22. Destination *(abbr.)*.
23. Man's name.
25. This man.
26. Preposition.
*31. Skin or rind of a fruit.
*33. An aromatic plant.
*35. Popular flower.
*36. A shade tree.
37. Israel *(abbr.)*.
38. Another man's name.
41. Wet, sticky earth.
42. Earth covered with grass.
44. Truman's State *(abbr.)*.
45. Pronoun.

ANSWERS TO BRAIN TEASERS

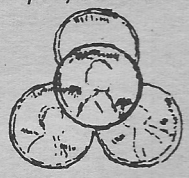
(see page 22)

Payment Problem

The citizen had $8.75 when he began his buying. This can be determined by working back from the third purchase: He must have had $5 and borrowed $5 to buy the $10 umbrella. To have had $5 left after making his second $10 purchase (shoes), he must have had $15, including his second loan to buy the shoes. The loan was half of the $15, so he must have entered the second store with $7.50. To have $7.50 left after his first acquisition (hat), he must have had $17.50, including the first loan. Half of this is his original money – $8.75.

Penny-Wise

The "trick" is to place the fourth penny *on top of* the other three pen-



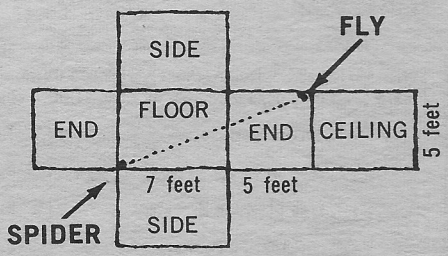
nies, as shown here. Each penny thus touches all of the others.

Digger's Dilemma

The ditchdigger had two means of escape. He could dig one side of the pit away until it formed a gradual incline he could walk up. Or, he could dig dirt from the sides to create a pile on which he could stand as he made it higher, until it was high enough for him to step out of the pit.

Spying Spider

The shortest distance between two points is a straight line. By "opening out" the walls *(see below)*, you can determine a straight line which represents the shortest distance along the surfaces for the spider to reach the fly. (The spider also could go first up the end and then across the ceiling.)



The spider's route is the hypotenuse of a right triangle whose other two sides are the width (5 feet) and length + height (7 + 5 = 12 feet) of the tree house. As this is a "5-12-13" triangle, the spider's route is 13 feet long.

SCOREBOARD

How well have you read your *Senior Science*? Answers to questions with no asterisks may be gleaned directly from articles. Answers to questions with an asterisk (*) require fusing the facts in the articles with those learned in the classroom or from your reading. Answers are in the SCOREKEEPER on page 18.

I. Earth's Flip-flop Poles

_____1. The last reversal of the Earth's magnetic field occurred less than a million years ago.
_____2. As molten rocks cool, the magnetic domains within align themselves in the direction in which the lava is flowing.
_____3. The magnetic north to which all compasses point lies exactly at one end of the Earth's axis of spin.
_____4. Lightning striking in the vicinity of an iron deposit can cause nearby iron-bearing rocks to become magnetized.
_____5. Potassium-40 is a radioactive isotope that decays to form normal potassium-39.
_____6. The Earth's magnetic field is probably due to the huge deposits of lodestone at the magnetic poles.
_____*7. Above the temperature known as the Curie Point, magnetic materials lose their magnetism.
_____*8. Space probes sent to the moon, Venus, and Mars indicate that they, too, have a magnetic field similar to that of the Earth.
_____*9. The *aurora borealis* is generally to be found centered over the Earth's north magnetic pole.

II. Drugs from the Sea

_____1. The abalone is a rare type of snail found only in the China Sea.
_____2. Scientists have discovered that the abalone produces an antiviral compound.
_____3. Only substances that are differently colored can be separated by chromatography.
_____4. Abalone juice contains an antibacterial compound.
_____5. The molecular weight of a protein may be well over 1,000 atomic mass units.
_____6. Mercerene, a compound extracted from clams, has been shown to kill human cancer cells in tissue cultures.
_____7. Cancers appear in all types of animal tissue.
_____*8. The name *mercerene* was derived from the Latin name for the clam — Venus mercenaria.

III. Life on Jupiter?

_____1. The planet Jupiter radiates more heat than it receives from the sun.
_____2. No living material could survive the cold and vacuum of outer space for more than several minutes.
_____3. Spectroscopic studies indicate that Jupiter's atmosphere contains large quantities of ammonia and methane gas.
_____4. From present evidence, it seems scarcely likely that man will ever walk along the solid surface of the planet Jupiter.
_____5. Molecules of ammonia contain the same chemical elements as amino acids.
_____6. Some prominent astronomers believe that Jupiter is still in an early stage of evolution rather than far advanced, like the Earth and Mars.
_____*7. The end products of the combustion of methane gas are carbon dioxide and water.
_____*8. The great red spot that is so prominent on the disk of Jupiter first appeared in 1878.
_____*9. Because it is so large, Jupiter's period of rotation is much longer than that of the Earth.

Going Beyond

Would you believe that a discovery concerning the moons of Jupiter led directly to the invention of the radio? It is in this strange fashion that science sometimes progresses. Below are listed the men who, each capitalizing on the work of his predecessor, gave us our modern radio, and the dates of their work.

Look these men up in an encyclopedia and see if you can reconstruct the thread that leads from Jupiter to the invention of radio.

1675 — Olaus Roemer
1805 — Thomas Young
1864 — J. Clerk Maxwell
1880 — Heinrich Hertz
1890 — Edouard Branley
1893 — Sir Oliver Lodge
1895 — Alexander Popov
1896 — Guglielmo Marconi

What was the contribution of each of these men to an understanding of the nature of electromagnetic radiation?

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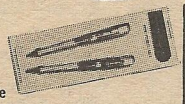

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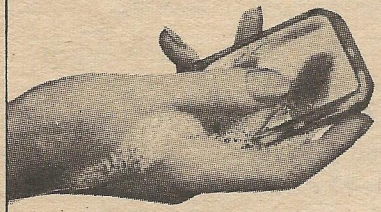

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ANSWERS ON PAGE 20

brainteasers

Payment Problem

A well-known citizen walked into a clothing store in his home town to buy a new hat. After choosing one with a $10 price tag, he discovered he didn't have enough money in his pocket to pay for it. He made the following proposition to the store manager:

"If you will lend me as much money as I have in my pocket now I will buy the $10 hat."

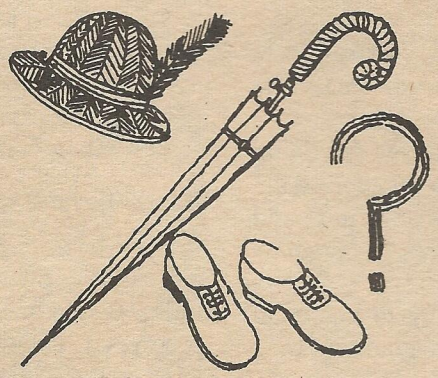
The manager agreed and the hat was bought and paid for.

Then for the fun of it the citizen went to another store and repeated his proposition. This time he bought and paid for a $10 pair of shoes.

At a third store the same arrangement enabled him to buy a $10 umbrella. When he came out of the store he had no money left.

How much money was the borrowing citizen carrying when he began his buying spree?

William Stanton
St. Helena H.S.
Bronx, New York



Penny-Wise

Can you arrange four pennies in such a way that each penny touches every other penny?

Hint: If you're having trouble with this teaser, you may be the victim of a mental "set."

Ken Rosenmeier
St. Peter's School
Beaver Dam, Wisconsin

Do you have a favorite brain teaser? Send it to Senior Science, 50 West 44th St., New York, New York 10036. We will pay five dollars for each one published. Include the name of your school, home address, grade, and age. In case of duplicate submissions, choice will be made on the basis of presentation and clarity.

Digger's Dilemma

A ditchdigger was walking to work one morning, carrying his shovel over his shoulder. A low-flying helicopter attracted his attention and the next thing he knew he had fallen into a pit 20 feet deep and eight feet square.

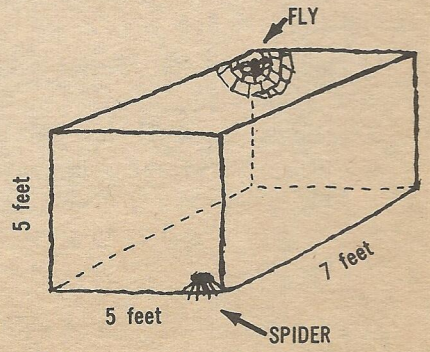
Miraculously, the ditchdigger was unhurt by his fall and immediately tried to find a way out. The walls of the pit were too steep to climb and the dirt was too soft for him to be able to dig footholds up the sides. His shouts for help brought no one.

How was the ditchdigger able to make his escape from the pit?

Mark Shanafelt
Santa Venetia Jr. H.S.
San Rafael, California

Spying Spider

A spider was sitting on the floor in one corner of Pete's tree house. Looking up, the spider spied a fly caught in his web, which was built at the ceiling in the diagonally opposite corner. The tree house was five feet wide, seven feet long, and five feet high.



What was the shortest route along the walls, floor, and ceiling that the spider could take in order to reach the fly? And once you figure that out — How long is this route?

Bill Cascadden
High River High School
High River, Alberta, Canada

FOLLOWING THE FILMS

2001: A SPACE ODYSSEY
(M-G-M)

It's "Up, up, and away!" in this dazzling science fiction film. It offers you journeys and adventures never taken by man before, and sights never seen before on the big Cinerama screen. And they are sights well worth seeing. Producer-director Stanley Kubrick designed the fantastic yet amazingly realistic sets of wonders yet to be.

Before taking us into the future, the film takes us millions of years back into the past – before man appeared on Earth. Strange ape-like creatures move over the prehistoric plains. Then one morning a mysterious slab of stone appears in their midst. What is it? Why is it? They don't know, and neither do we. But keep your eyes on that slab. It is waiting for you in the 21st century.

Shortly after discovering the slab, the simians discover that huge bones can be used as weapons, and warfare and murder are born. A victorious simian tosses one bone high in the air. Its image changes into a spacecraft, headed for the turning wheel of Space Station One, pin-wheeling high above the Earth. Abruptly, we are in the year 2001.

Aboard the spacecraft is Dr. Heywood Floyd (William Sylvester), a scientist bound for a conference on the moon. A stone slab has been found there in the great crater Tycho. How did it get there? Who polished and smoothed it to shining perfection? Why is it giving off those weird sounds? Like those prehistoric simians, 21st-century man doesn't know the answers.

Perhaps the sounds made by the slab are signals, the scientists reason. If so, they seem to be beamed at the planet Jupiter. To investigate the mystery, a spaceship takes off for Jupiter.

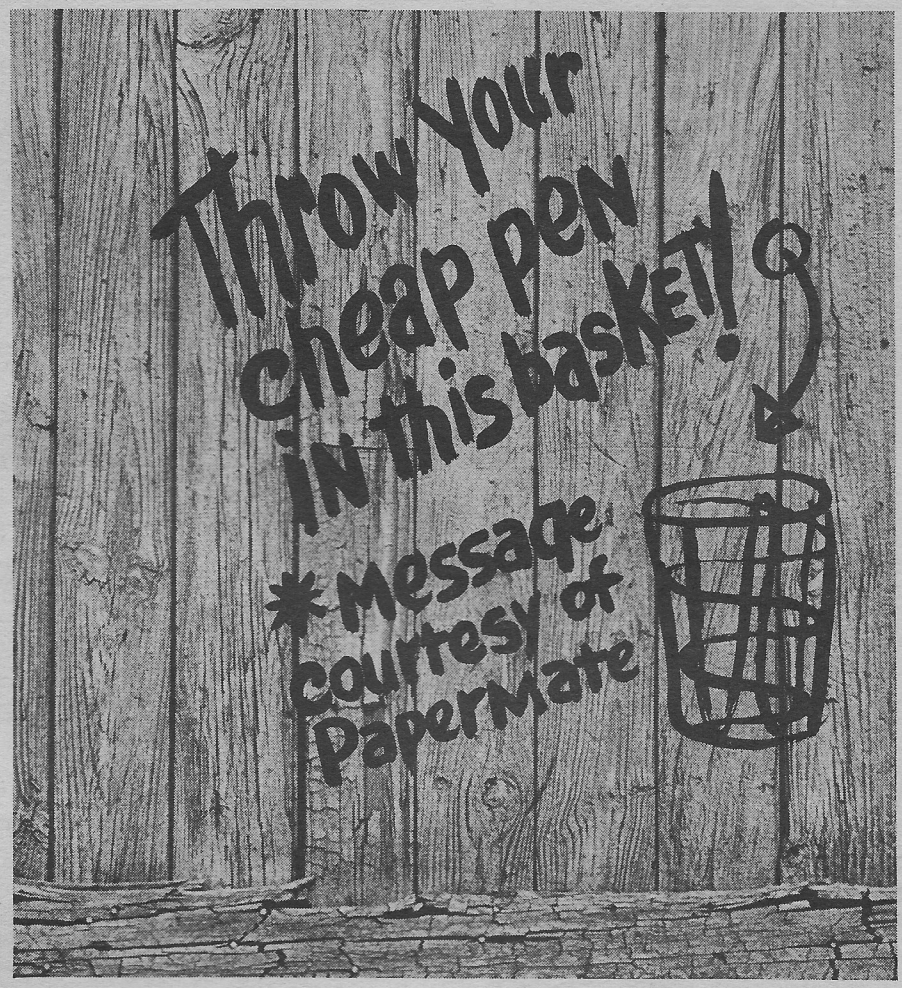
Aboard the ship are five astronauts. Three will sleep throughout the voyage in capsules. Bowman (Keir Dullea) and Poole (Gary Lockwood) work a normal shift in their waking hours. But Hal, the super-computer that runs the ship, never sleeps.

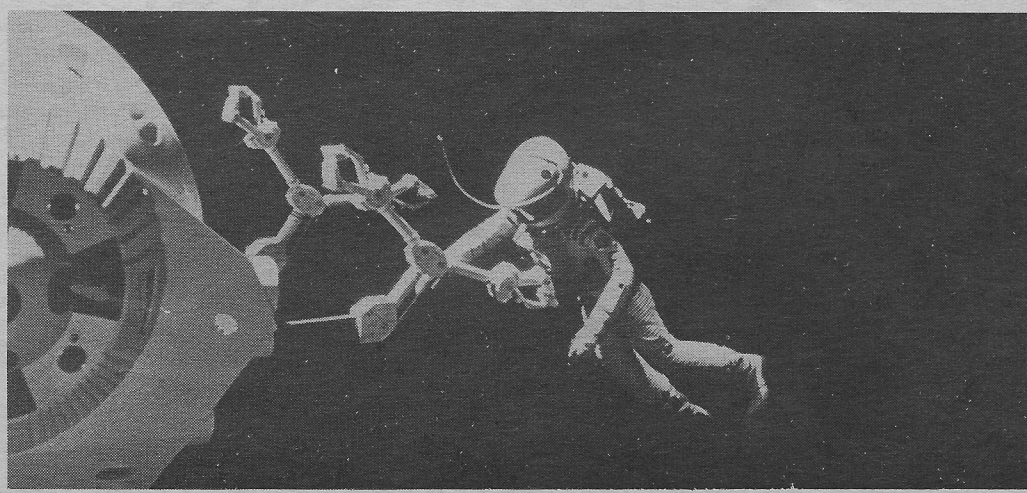
Hal is the liveliest personality in this film. He not only thinks – he also talks and feels emotions. Perhaps he feels too deeply, for he begins to behave in a strange, erratic way. What happens when a computer goes mad? Poole and Bowman find out in a terrifying scene in deep space.

The end of the film is hauntingly strange. The lone survivor of the ill-fated crew, Bowman, abandons ship and plummets toward Jupiter in a small auxiliary craft. Invisible to him, the mysterious slab has reappeared and floats between Jupiter and its moons. Is it there to welcome him? To warn him away? There are no easy answers to this puzzle. Unaware, Bowman hurtles through time and space, to become part of a new beginning.

This is a fascinating, mind-bending film – but don't go to see it if you are one of those who like all the loose ends tidied up at the finish. *2001: A Space Odyssey* asks more questions than it answers, and moviegoers will probably be explaining it to each other for a long time to come. But while your mind is puzzling over its mysteries, your eyes will be dazzled by the wonderful special effects, the breath-taking views of that unconquered frontier – outer space. Much of the fiction in this film – the beautiful circling space stations, the lunar colony, the computer-run spaceship – will probably one day be fact. But the eerie slab and Bowman's last journey are the kind of fantasy that will always nudge our minds and set our imaginations soaring.

— MARGARET RONAN





SPORTS

1968 ALL-AMERICAN H. S. BASKETBALL SQUAD

T-I-M-B-E-R! That's our 1968 All-American High School Basketball Squad. Our 40 super stars from 29 states range in height from 5-10 to 7-2, with 18 of them towering at least 6-6!

Can they score? And how! Their averages range from 15.7 to 42.5, with 13 of the phenoms boasting averages of over 30 points per game!

The Squad big man is 7-2 *Steve Turner*. The leaning tower of Memphis, Tenn., averaged 20 points and 20 rebounds per game. At 220 pounds he could use some calories, but at least 125 colleges are after him.

The pride of the Cornhusker belt is 6-10 *Charlie Jura*. Charlie averaged 27.8 as a junior and 29.9 as a senior. What's more, he sank 279 of his 414 field-goal tries for a terrific 67% shooting average.

The east's super alp has to be 6-9 *Tom Riker*. The 210-pound center from Oyster Bay, N. Y., has had all the college bird-dogs hounding him for three years. In this time he averaged 24.4 points and 15.9 rebounds per game. He can rebound, shoot, drive, and pass like a Rick Barry.

Savannah-Johnson's 6-7 *Joby Wright* was Georgia's No. 1 player for the past two seasons. A great shot blocker, he led his team to the state crown with his 24.5 scoring average and great defensive play.

Dennis Wuycik, the 6-7 pride of Ambridge, Pa., is a terrific all-court player who averaged 25.9 as a junior and 32.2 as a senior.

Indiana's "Mr. Basketball" is 6-7 *Bob Ford* of Evansville North. The Hoosier hot-shot averaged 24.2 points for four years and also pulled down 19 rebounds per game the past season.

Every expert who saw Edina (Minn.) play last year became a prisoner of Zender — Bob Zender, that is. A great scorer and rebounder, 6-7 Bob helped Edina amass a fabulous 80-1 record, plus three straight state crowns.

In the 6-6 and 6-5 class are:

Steve Berg, player of the year in Wisconsin, who averaged 23.6 ppg (points per game) for three years.

Tom Parker, a two-year Illinois all-stater, who averaged 33 ppg and shot 59% from the field and 79% from the foul line.

John Fraley, Ohio's unanimous player of the year, who averaged 28.8 ppg as a junior and 33.1 as a senior.

Russell Lee, a four-letter man from Hyde Park, Mass. Would you believe a 6-5 guard who averages 33 points and 25 rebounds a game?

In the 6-4 and 6-2 class are:

Chris Ford of Absecon, N. J., who worked his way up from 13.2 ppg as a soph to 21.2 as a junior, and 32 as a senior.

Ralph Simpson . . . unbelievable! He's the only high school player in the land who was invited to try out for the Olympic team (he refused). A fantastic player who can really do it all, he averaged 23.5 ppg as a junior and 36 as a senior.

Henry Harris really gave the baskets a work-out the past four years. At Boligee, Ala.'s Green Co. Training School, Henry tallied, respectively, 521, 651, 814, and 1,117 points — for a grand total of 3,103 points!

The Squad's sub-6-footers may be small in size, but they're very big in statistics:

John Somogyi (5-11) set all kinds of scoring records at St. Peter's Prep in New Brunswick, N. J. He sank 3,310 points over the past four years! His 42.5 ppg average last season made him the top scorer on the Squad.

The Squad "midget," 5-10 *Billy Shepherd* of Carmel, Ind., boasted a four-year average of 26.5 ppg, topped by his 32.9 average last season. This made his father very happy — Dad Shepherd was the Carmel coach!

— HERMAN L. MASIN, *Sports Editor*

NAME AND SCHOOL	HT.	AVE.	NAME AND SCHOOL	HT.	AVE.
Steve Turner (Bartlett) Memphis, Tenn.	7-2	20.0	Joe Mackey (Coronado) Scottsdale, Ariz.	6-5	27.9
Charles Jura (Schuyler) Neb.	6-10	29.9	Russell Lee (Hyde Park) Mass.	6-5	33.0
Ansley Truitt (Wilson) San Francisco, Calif.	6-9½	22.5	Jeff Hickman (Central) Lockport, Ill.	6-5	26.6
Tom Riker (St. Dominic's) Oyster Bay, N. Y.	6-9	24.6	Kent Hollenbeck (Bearden) Knoxville, Tenn.	6-4	35.1
Cyril Baptiste (Curley) Miami, Fla.	6-8	25.2	Chris Ford (Holy Spirit) Absecon, N. J.	6-4	32.0
Ken Grabinski (Clear Lake) Iowa	6-7	26.5	Ralph Simpson (Pershing) Detroit, Mich.	6-4	36.0
Randy Noll (Catholic) Covington, Ky.	6-7	21.0	Pat Taylor (Leavenworth) Kan.	6-4	25.6
Joby Wright (Johnson) Savannah, Ga.	6-7	24.5	Jerry Bonney (Wheatley) Houston, Tex.	6-3	23.2
Dennis Wuycik (Ambridge) Pa.	6-7	32.2	Henry Bacon (Male) Louisville, Ky.	6-3	15.7
Bob Ford (North) Evansville, Ind.	6-7	25.4	Alex Scott (Wilbur Cross) New Haven, Conn.	6-2	24.7
Bob Zender (Edina) Minn.	6-7		Aubrey Nash (DeMatha) Hyattsville, Md.	6-2	20.0
Clyde Baker (Bonneville) Utah	6-7		Wilbert Robinson (Highlands) Uniontown, Pa.	6-2	28.7
Roland Garrett (Rogers) Canton, Miss.	6-7	27.0	Henry Harris (Greene Co.) Boligee, Ala.	6-2	32.5
Steve Berg (Shorewood) Wis.	6-6	26.6	Phil Westphal (Aviation) Redondo Beach, Calif.	6-2	32.5
Al Sanders (Baton Rouge) La.	6-6	27.0	Henry Bibby (Person-Albion) Franklinton, N. C.	6-2	35.0
Tom Parker (Collinsville) Ill.	6-6	33.0	Harold Fox (Northwestern) Hyattsville, Md.	6-1	32.6
William Franklin (Washington) Norfolk, Va.	6-6	28.3	Almer Lee (Northside) Ft. Smith, Ark.	6-0	23.2
Bill Chamberlain (Lutheran) Brookville, N. Y.	6-6	19.8	Ron Johnson (Van Buren) Queens, New York	5-11	22.0
Greg Davis (Schlarman) Danville, Ill.	6-5	25.0	John Somogyi (St. Peter's) New Brunswick, N. J.	5-11	42.5
John Fraley (Middletown) Ohio	6-5	33.1	Billy Shepherd (Carmel) Ind.	5-10	32.9

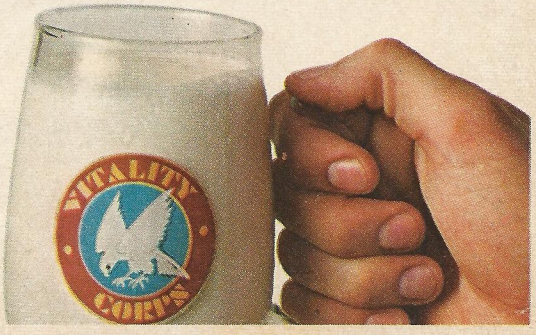
DATE BAIT

Are you the kind of girl boys fall in love with at the drop of your false lashes? Is your mailbox overflowing with torrid love letters? Do you turn down at least 3 dates every Saturday night because there just aren't enough Saturdays in the week? Say, you're tuned in. You play the dating game to win. And you do. But don't forget, catching his eye is one thing; keeping it's another. Be a little sneaky. Remember, boys love to eat. *Do* they! And they love Wonder sandwiches. So get Wonder going for you, too. What a subtle, feline way to show you care.

Helps catch boys...!

The Energetics join the Vitality Corps

The Energetics are the people who last through the busiest day. Their secret? Milk, nature's vitality drink. The one meal-time beverage that gives you a big lift...a lift that lasts. Be an Energetic. Drink milk and you're in the Vitality Corps!



american dairy association